

IPRO 362: MORE Life Project

Project Plan

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[We are still in the process of recruiting collaborators from the medical profession].

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Purpose The purpose of team M.O.R.E life (IPRO 362) is to be able to design a cost-effective mobile operating room that can be easily deployed and transported into disaster relief situations in order to provide a sterile and sanitary surgical environment for the victims of these. This will be accomplished by an interprofessional team of individuals that will employ engineering, architectural and social scientific skills to identify the key factors involved in disaster relief situations. Research conducted while consulting with medical personnel, partnering with health and catastrophe relief organizations and collaborating with individuals with experience in these situations will be fundamental in accomplishing the goals of the project.

As this is the second semester that this IPRO is running, the team will build on the work completed last semester with the goal of building and testing prototypes in context. We aim to do at least one round of prototype testing with the assistance of a collaborator in Uganda, where everyday conditions in medical environments mimic disaster relief conditions more closely than in Chicago. This prototype testing will aid in the refinement of the mobile operating room design.

Objectives

The objective of IPRO 362 is to understand the environment in which disaster victims are found and the human needs involved. Additionally, understanding the medical standards of sanitation, sterility and environmental control conditions that are expected in an operating room are all central to developing a human-centered design. In order to be able to ensure the success of the M.O.R.E. Life project, design needs to focus on the following:

MEDICAL PERSONNEL

- Provide the necessary tools and equipment which medical personnel need in order to perform medical interventions
- Identify and provide a surgical environment satisfying necessary sanitary, given the environmental limitations in a disaster relief situation.

STRUCTURE/PORTABILITY

- Work to make the mobile operating room (M.O.R.E) design as compact as possible, while still keeping sanitary standards as high as possible.

FILTRATION

- Design an effective filtration system that will allow for environmental control within the structure.
- Address sanitation by taking into account airborne pathogens can be filtered out of the air.

POWER

- Design an energy-efficient power system for the mobile operating theatre, considering alternative energy sources.

DESIGN

- Create and refine a design for the operating theatre, including a carrying case.
- Replicate standard operating room conditions in the mobile version.
- Conduct a market analysis to identify key stakeholders, advantages and disadvantages of existing products and current costs.

Concept

The concept that the MORE Life project is pursuing is to create a portable (collapsible) sanitary structure with an air filtration mechanism that can provide a sterile environment in which medical treatment can take place. The intention is that the final product will collapse and fit into a backpack that could be easily transported by medical brigade units into disaster relief areas. The MORE product system will be self-powered, easily deployable and portable. It will effectively address and work to accommodate the precarious conditions that health care professionals working in disaster relief situations experience.

Background History

During the December 2004 Indian Ocean tsunami and earthquake, \$6.2 billion worth of donated medical supplies were not delivered to aid in the medical relief effort due to the obstacles set up by not only the cost, but also the difficulties of transporting the equipment into such harshly ruined environments where mudslides and torn up roads prevented the supplies from getting to the center of the disaster.¹ During the 2008 earthquake in Sichuan, China, the rough terrain and close proximity of the earthquake's epicenter made it difficult for soldiers to get medical help into the rural regions of the province. Rock slides, persistent rain and mud covered main roads played a major role in the hindering of the rescue officials' relief effort as it prevented medical field hospitals from being accessible to all the injured victims in those areas. In 2005, the natural disaster known as Hurricane Katrina made landfall and destroyed New Orleans, Louisiana. Citizens were relocated to the Superdome where the healthy, the sick, the injured and the dead all remained within a small proximity of each other and remained in unsanitary conditions for days on end. The humid environment, in combination with the dirty water acquired by the flood and rainfall, was a breeding ground for bacteria and infection. In addition, the failure of the levee systems and further flooding of the entire state provided an obstacle in getting medical help and field hospitals in by roads. This resulted in New Orleans as a lack of being adequately prepared for the full evacuation of medical facilities. Citizens were relocated to the Superdome where the healthy, the sick, the injured and the dead all remained within a small proximity of each other and remained in unsanitary conditions for days. As all these examples suggest, there is a need to provide a sterile and safe environment that can be rapidly deployed and offers accessibility despite the environmental condition in which the individual is found².

Technology

There are technologies available to aid such situations however; none of them are accessible in all conditions where main roads or airports may not be available for use. Currently medical relief is available in disaster areas which operate using a mobile operation unit. These units are currently the military as well as by organizations such as the Red Cross³ and Doctors Without Borders⁴. I as by organizations such as the Red Cross and Doctors Without Borders. The mobile operating units must meet U.S. Health Care Standards. The DRASH units provide fully integrated lighting and electrical systems to provide ample light, they use generators as a power source, heat and cool the unit to allow for optimal environmental conditions even in extreme conditions and they contain isolation capabilities which allow medical personnel to treat infection⁵. These facilities also contain pre-op and post-op areas which are able to accommodate a capacity of two or three patients. Nurse stations are also available within these units which allow for visual and electronic monitoring of all the systems. This unit has shown that operations can be done in a small area with the right equipment. M.O.R.E. Life attempts to engineer a self-powered, portable, and easily deployable structure that will allow accessibility in all environmental situations (O.R.) standards⁶.

¹ Asian Development Bank, <http://www.adb.org/Documents/Produced-Under-TA/39127/39127-01-INO-DPTA.pdf>

² U.S. Government Printing Office, <http://www.gpoaccess.gov/katrinareport/execsummary.pdf>

³ Red Cross, <http://www.redcross.org/portal/site/en/menuitem.94aae335470e233f6cf911df43181aa0/?vgnnextoid=99b36d585ce26210VgnVCM10000089f0870aRCRD>

⁴ Doctors without Borders, <http://www.doctorswithoutborders.org/aboutus/?ref=main-menu>

⁵ DRASH military supplies, <http://www.drash.com/Applications/Medical.aspx>

⁶ Center for Disease Control (CDC), <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5210a1.htm>

The M.O.R.E. life design aims to help victims of disasters and provide aid in places where current operation room devices are unable to reach. This help should be available to as many people as possible. The adherence to the Code of Ethics will be crucial in providing aid that is both beneficial and ethical. Treatment for every casualty will raise many ethical issues. Most of this aid will be deployed in areas where destruction and the ruin of infrastructure has recently occurred; this in itself will bring about the ethical issue of authority when making the medical aid resources available. The situation will be a highly chaotic one that will also serve as a challenge when establishing the ethical and practical system of medical priorities. Triage will involve setting priorities among patients with various degrees of medical urgency. Usually this involves three important questions that must be answered: "How urgent is this patient's condition? Do we have adequate resources to meet this patient's needs? And assuming we admit this patient and provide the level of care required, can the patient's life be saved?" Ethical issues also arise when determining the injuries of late-arriving patients. With these patients there will be a higher chance of fatality, and since there is no specific cut of time beyond which the patient could not be saved, these cases would most likely have to be based on an individual level of evaluation (per case basis). This may also mean that treating these admitted patients may potentially divert resources from patients that have a better chance of survival. Other ethical issues arise when taking in patients with severe brain and spinal injuries, based on available staff and equipment as denying care to some patients for the benefit of others was not a course of action to be taken. Decisions also will have to be made to determine the placement and treatment options of each patient. One example of how to go about this situation may be taken from the relief efforts in Haiti.

Ethics and Society

"To deal with the ethical aspects of decisions regarding patient placement and treatment options [in Haiti], we created a system of ad hoc ethics committees. The physician who was directly in charge of caring for a certain patient would present the case to a panel of three senior physicians, who would decide how to proceed — a system that relieved individual physicians [had] the burden of determining a given person's fate. Decisions that were reached by the committee were recorded and became part of the patient's file."⁷

Further issues also arise when it comes to the functionality of the medical personnel and activity in relation to surgeries, discharge and the further continuation of urgent care required⁸. The humane conditions and environmental control within the tent will also pose ethical issues and challenges; these challenges will be further addressed this semester.

⁷ New England Journal of Medicine, <http://www.nejm.org/doi/full/10.1056/NEJMp1001693>

⁸ Direct Relief International, <http://www.directrelief.org/EmergencyResponse/EmergencyResponse.aspx?id=682&linkidentifier=id&itemid=682>

Work Plan

- Week 1** + Familiarization with work done last semester
- Week 2** + Begin drafting a list of questions for expert interviews
 - + Form sub-teams
 - + Contact experts and finalize design criteria
- Week 3** + Contact experts and finalize design criteria
- Week 4** + Present final design criteria for MORE Life system based on input from experts
 - + Facilitated ideation session
 - + Create prototyping plan
 - + Create scale models that embody design criteria
- Week 5** + Present scale mock-ups for review
 - + Presentation on full scale prototyping
 - + Review of appropriate design competitions
 - + Begin building full-scale prototypes
- Week 6** + Present full-scale prototypes for review
 - + Develop field testing plan
 - + Update on design competitions and deadlines
 - + Peer evaluation
 - + Continue building full-scale prototypes
- Week 7** + Presentation on contextual field testing
 - + Present full-scale prototypes for review
 - + Finalize field testing plan
 - + Update on design competitions and deadlines
 - + Complete full-scale prototypes
 - + Begin field testing
- Week 8** + Presentation on contextual field testing
 - + Present full-scale prototypes for review
 - + Finalize field testing plan
 - + Update on design competitions and deadlines
 - + Complete full-scale prototypes
 - + Begin field testing
- Week 9** + Continue field testing
 - + Refine prototypes based on results of field testing
- Week 10** + Report on field testing progress
 - + Discuss refinements to prototype based on testing
 - + Presentation on medical design for the Base of the Pyramid
 - + Complete field testing
 - + Refine prototypes based on results of field testing
 - + Begin preparing layouts for poster, competition boards
- Week 11** + Refine prototype based on field testing
 - + Build refined prototype
 - + Develop field testing plan
- Week 12** + Finalize changes to existing prototype in preparation for second round of field testing
 - + Present field testing plan
 - + Build refined prototype
- Week 13** + Present final refined prototype
 - + Confirm field testing plan
 - + Complete full-scale prototypes
 - + Begin field testing
- Week 14** + Refine design based on field testing outcomes
 - + Begin developing final presentation, poster and competition board layouts
 - + Continue design refinement and field testing
- Week 15** + Present final refined prototype based on testing results
 - + Complete full-scale prototypes based on field testing
 - + Develop final presentation, poster and competition board layouts.